PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : F24D 19/10 — A1

(11) International Publication Number: WO 90/01657

(43) International Publication Date: 22 February 1990 (22.02.90)

(21) International Application Number: PCT/DK89/00185

(22) International Filing Date: 2 August 1989 (02.08.89)

(30) Priority data:
4416/88 5 August 1988 (05.08.88) DK

(71) Applicant *(for all designated States except US)*: FRESE ARMATUR A/S [DK/DK]; Sorøvej 6, DK-4200 Slagelse (DK).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : MOESBY, Peter [DK/DK]; Kenyavej 3, DK-4200 Slagelse (DK).

(74) Agent: LARSEN & BIRKEHOLM A/S SKANDINAVISK PATENTBUREAU ; Postboks 200, Skagensgade 64, DK-2630 Taastrup (DK).

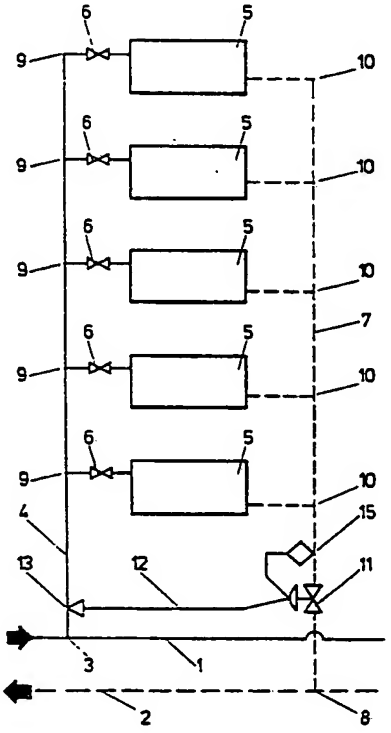
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
In English translation (filed in Danish).

(54) Title: METHOD OF REGULATING A CENTRAL OR DISTRICT HEATING PLANT BY MEANS OF A DIFFERENTIAL PRESSURE VALVE, AND UNIT FOR WORKING METHOD

(57) Abstract

The invention relates to a method for regulating a central heating plant for several rooms having a radiator (5) provided with a thermostat valve (6). The plant has a differential pressure valve (11, 111) placed downstream as compared to the radiators, with a closing device controlled by a membrane (23) for regulating the flow of heat carrying fluid in a passage (19) between an inlet (17) and an outlet (18). If the windows in several rooms are opened the thermostat valves (6) will open, whereupon the differential pressure valve should regulate the combined flow, which it cannot do since the pressure difference across the two surfaces of the membrane (23) is small even by full flow. This drawback is avoided by means of a differential pressure valve (11, 111) with an adjustable throttle (15) between the inlet (17) and the closing device (24, 25), and by adjusting the throttle, regardless of the pressure distribution, to allow the maximum amount of fluid to pass. The invention also relates to a single pipe and a double pipe central heating plant with the differential pressure valve (11, 111).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic			SE	Sweden
CG	Congo	KR	Republic of Korea	SN	Senegal
CH	Switzerland	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
DE	Germany, Federal Republic of	LU	Luxembourg	TG	Togo
DK	Denmark	MC	Monaco	US	United States of America
FI	Finland	MG	Madagascar		

METHOD OF REGULATING A CENTRAL OR DISTRICT HEATING PLANT BY MEANS OF A DIFFERENTIAL PRESSURE VALVE, AND UNIT FOR WORKING METHOD.

The invention relates to a method of regulating a central or district heating plant provided with a differential pressure valve for circulating a heat carrying liquid, such as water, in a building with several rooms, each of which has at least one radiator controlled by a thermostat valve, said differential pressure valve being placed after the radiators in the direction of flow and having a closing device controlled by a membrane for regulating the flow of the heat carrying liquid through a passage between an inlet and an outlet.

In central heating plants it is important that the water is distributed through the plant in a previously calculated proportion in such a way that the dimensioned heat requirements of the individual radiators are taken into consideration.

It is also important that the heat carrying liquid remains in the plant for so long as to allow an adequate amount of heat to be dissipated to the rooms in the building, which is to be heated by the plant, and this is secured by means of a differential pressure valve placed in the individual branches of the plant, which valve can regulate the flow of the heat carrying liquid.

Furthermore, it is important that the differential pressure across the individual radiators is so small that noise is not generated in the valves, because such noise may cause inconvenience, directly or by transmission

through the piping system.

In the individual rooms the flow of the heat carrying liquid through the radiator or through each radiator is controlled by means of thermostat valves which, depending upon the room temperature, can open more or less to the flow through the radiator or radiators respectively in such a way that the emission of heat to the room can be kept within the limits, which are determined by the accuracy of the thermostat valves, and the temperature, which the user of the room has decided to maintain, by adjustment of the thermostat valve or valves.

In this normal function of the plant the thermostat valves control the system, and the differential pressure valve assumes its previously fixed setting, which is determined by the total dimensioning of the plant, as the combined number of thermostat valves will cause an appropriate pressure drop across the plant.

However, in a plant like this a situation will often arise which will deviate from this predetermined normal function.

This may for example occur when early in the morning open the cleaning personnel open the windows in several rooms to air the rooms prior to the arrival of the users of the individual rooms at normal working hours.

When the window or the windows are opened in a room in which there are radiators provided with thermostat valves these ought to be turned off to the flow of the heat carrying liquid.

Experience shows that the radiators are rarely turned off, and therefore several hours may pass with the windows left open, whereby the thermostat valves open fully for each radiator, especially at low outdoor temperature.

In this situation it is the differential pressure valve which must control the combined flow through the plant, but this cannot be accomplished since the pressure difference between the two surfaces of the membranes is small, even by full flow through the valve.

Therefore in this abnormal but nevertheless often recurring situation, a disproportionately large amount of the heat carrying liquid will flow through the plant with a poor economy as a consequence.

The purpose of the invention is to counter the above mentioned drawback, and this purpose is achieved through the method in question, which method according to the invention is characterized in that the differential pressure valve is provided with an adjustable throttle between the inlet and the closing device, and that the throttle is adjusted to allow a maximum amount of liquid to pass, regardless of the state of distribution of the pressure in the plant.

By providing the differential pressure valve with the said adjustable throttle the total amount of heat carrying liquid through the plant can be limited even if all of the thermostat valves are opened at a maximum, which means that the throttling, which normally takes place in the plant by the combined effect of a plurality of thermostat valves, is transferred down to the differential pressure valve. In this way a constant loss of pressure is provided

across the thermostat valves and/or the throttle in the differential pressure valve, regardless of whether the thermostat valves are more or less open.

The invention also relates to a central or district heating plant for use in the implementation of the method according to the invention, said plant being designed for conducting a heat carrying liquid, such as water, and comprising several radiators, each provided with a thermostat valve, said radiators being designed to be placed in a number of at least one in each room in a building, and a differential pressure valve being placed after the radiators in the direction of flow, said valve having a closing device controlled by a membrane for regulating the flow of the heat carrying liquid through a passage between an inlet and an outlet, and said plant according to the invention being characterized in that the differential pressure valve has an adjustable throttle between the inlet and the closing device.

The subclaims indicate ways, respectively means for the implementation of the method. The expediency of these will appear from the following description.

The method will be explained in more detail in the following with reference to the drawings which illustrate a plant for use in the implementation of the method, and in which

Fig. 1 is a schematic view of a double pipe central or district heating plant according to the invention,

Fig. 2 is a schematic view of a differential pressure

valve according to the invention for use in the double pipe plant shown in fig. 1,

Fig. 3 shows the distribution of differential pressures in the plant shown in fig. 1,

Fig. 4 shows the regulation of the amount of water in the same plant,

Fig. 5 is a schematic view of a single pipe central or district heating plant according to the invention,

Fig. 6 is a schematica view of a differential pressure valve according to the invention for use in the single pipe plant shown in fig. 5,

Figs. 7 and 8 show preferred embodimemnts of the differential pressure valves shown in fig. 1 and in fig. 5, respectively.

A double pipe central or district heating plant according to the invention comprises a main supply pipe 1 and a main return pipe 2 which conduct a heat carrying liquid, such as water, from and back respectively to a boiler unit (not shown in the drawing) of generally known type.

From a branching point 3 a side supply pipe 4 conducts the heat carrying fluid to a number of radiators 5, each of which is provided with a thermostat valve 6, which according to its setting and the temperature of the room, in which the radiator 5 is placed, can control the flow of the heat carrying liquid through the radiator 5.

The thermostat valves 6 are of a generally known kind and are not part of the invention and their construction will therefore not be described in detail.

A side return pipe 7 conducts the heat carrying liquid back to the main return pipe 2 at a connection point 8.

In fig 1 the supply pipes 1 and 4 are shown in full lines, while the return pipes 2 and 7 are shown in dotted lines.

The radiators 5 are connected to the side supply pipe 4 and the side return pipe 7 at connection points 9, respectively 10 and 10a.

A differential pressure valve 11 is inserted in the side return pipe 7 between the connection point 10a immediately preceding in the direction of flow and the connection point 8. The construction of this valve will be described in more detail in the following.

Furthermore a pipe 12 is provided in the plant in the shape of a capillary tube extending between a first point of reference 13 and a connection 14 on the differential pressure valve 11, which reference point 13 is positioned between the branching point 3 and the first connection point 9 for a radiator 5 in the direction of flow.

Between the above mentioned connection point 10a and the differential pressure valve 11 is provided a throttle 15, the area of the passage of which is adjustable.

The side pipes 4 and 7, the radiators 5, the termostat valves 6 and the differential pressure valve 11 in combination constitute a branching off of the main pipes 1 and

2.

A branching of this kind is for example intended for the heating of a number of rooms which are placed above each other in a building, such as a residential property or an office building.

A branching of the kind described may be placed at each entrance or stairway in the building.

The differential pressure valve 11 is shown schematically in fig. 2 and comprises a housing 16 with an inlet 17 and an outlet 18, which form the end points of a passage 19 through the housing 16. The inlet 17 is provided with means, for example a screw thread or a flange, by which it can be connected to the return branch pipe 7 in a flow-tight way, and the outlet is way adapted to be connected to the main return pipe 2 in a similar way. The arrow 22 shows the direction of flow.

The housing is furthermore provided with a bore 30, the axis 20 of which preferably, but not necessarily, extends at an angle in relation to the axis 21 of the passage 19.

Coaxially with the axis 20 of the bore 30 a membrane device is provided which can be controlled by a differential pressure.

The membrane device consists of a membrane 23 which is connected with a bellows 24 of elastic material. The bellows 24 can be described as a short tube, one end of which, at a radial distance, is turned back upon the other end, whereupon the radially outer part is tightly secured to the wall of the bore 30 and the radially inner part is

tightly connected to the membrane 23. During the displacement of the membrane 23 forwards and back in the direction of the axis 20 of the bore 30 the bellows will fold or roll upon itself to a larger or smaller degree whereby the radially outer part can become longer or shorter and roll across some axially extending slits 25 in the foremost end of a bushing 26 with a first end and an opposite second end, said bushing being referred to in the following as the second bushing. The slits 25 are placed at regular intervals along the periphery of the second bushing 26.

The connection of the radially outer part of the bellows 24 is effected by means of a membrane holder 27 which is secured in the bore 30 by means of a lid 28 which for example can be fastened to the housing 16 by screws or similar means of attachment.

The lid 28 carries the above mentioned connection 14 for the pipe 12. A hole 37 has been drilled in the membrane holder 27 in such a way that a pressure in the branch pipe 12 can act upon a first surface 29 of the membrane 24, said first surface being turned away from the passage 19 in the housing 16.

The second bushing 26 is mounted immovably and tightly in the bore 30 and extends through the passage 19. It is furthermore sealed in the housing 16 in such a way that the flow of a heat carrying medium through the passage 19 can only take place when the membrane is in positions where the bellows 24 more or less releases the slits 25 in the second bushing 26.

At the opposite end of the bushing 30 a spindle 31 with a

hand grip 32 is placed rotatably, said hand grip having a surface with friction enhancing means, such as a knurl, so that the hand grip 32 can easily be rotated, and the spindle 31 can thereby be rotated around its longitudinal axis, which is coincident with the axis 20 of the bore 30.

The spindle 31 is provided, on part of its surface of revolution, with a thread 33 which can co-operate with a thread in a bushing 34, which in the following will be referred to as the first bushing. The bushing 34 is mounted slidably in the bore 30. The spindle 31 is mounted immovably lengthwise and it will be understood that a turning of the hand grip 32 will result in a displacement lengthwise of the first bushing 34 towards or away from the membrane device.

The outer diameter of the first bushing 34 is adapted to a tight, sliding co-operation with the inside of the other end of the of the second bushing 26, said other end being provided with lengthwise passages or perforations 35 which are distributed at equal intervals along the periphery of the second bushing.

By means of the above mentioned turning of the hand grip 32 the first bushing 34 can be displaced inside the second bushing 26 between a first position where the free end part of the first bushing 34 will close the above mentioned lengthwise passages 35 in the wall of the second bushing 26, and a second position where a free flow is permitted through the passages.

With the differential pressure valve 11 being mounted in the plant as shown in fig. 1 it is possible by means of the hand grip 32 to adjust the first bushing 32 in rela-

tion to the second bushing 26 in such a way that the end part of the first bushing 34 will expose an appropriate area of the passages 35.

This area forms the above mentioned throttle 15 which is thus is built into the differential pressure valve 11.

A membrane spring 36 is mounted around the spindle 31 and is adapted to act upon the membrane in the direction of the lid 16, that is towards the position in which the membrane device permits the largest flow possible.

The pressure which during the flow of the heat carrying liquid through the differential pressure valve is present in the area between the passages 35 and the slits 25 will be compared by the membrane to the pressure which is sensed at the point 13, reference point A, in the side supply pipe 4 by means of the pipe 12, whereby the membrane 23 adjusts itself in its longitudinal direction so that the differential pressure, dependening upon the spring characteristic of the membrane spring 36, will be adjusted to an appropriate amount of flow.

Furthermore, the pressure in the side return pipe 7 after the nearest preceding connection point 10a, is measured at a point, reference point C, in the inlet 17 of the differential pressure valve 17

The working of the plant shown in fig. 1 will be explained in the following with referencve to the curves shown in figs. 3 and 4, which are obtained by simulation in a model.

The regulation characteristics of the differential pres-

sure valve is shown in fig. 3 as a function of the degree of opening of the thermostat valves 6 in the radiators 5 in the side pipes 4, 7. Thus 100% will correspond to the state of the dimensioning, and degrees of opening beyond that will correspond to a period of warming, for example following a night with lower temperatures or following the above described state in which the windows have been opened by cold weather without closing of the thermostat valves 6 at the same time.

Fig. 3 shows the distribution of the differential pressure across respectively the radiators in the side pipes 4, 7, that is, the reference points A and C and the regulated differential pressure across the radiators 5 and the throttle 15 combined, that is at the reference points A and B.

It will be observed that the differential pressure across the radiators 5 is always less than 1 mVs (water column pressure), and that the differential pressure across the throttle 15, which is indicated by the difference between the curves, remains substantially constant at degrees of opening above than 100%.

Fig. 4 shows the regulated amount of water in the side pipes 4, 7 and it will be observed that the amount of water is substantially constant at a degree of opening above than 100%.

A single pipe central or district heating plant according to the invention is shown in fig. 5 in which the same reference numbers are used for parts corresponding to one another.

The plant has a main supply pipe 1, a main return pipe 2, a branching point 3, a connection point 8, radiators 5 with thermostat valves 6, a differential pressure valve 11 and a throttle 15.

The termostat valves are of a slightly different shape as compared to the ones used in fig. 1, as they are designed to allow the heat carrying liquid to flow further on to the next thermostat valve 6 in the direction of flow.

The thermostat valves 6 are of a generally known kind and are not a part of the invention and their construction will therefore not be described in detail.

The differential pressure valve 111 differs from the above described differential pressure valve in that it does not have a connection corresponding to the connection 14 for the pipe 12 in the double pipe plant.

Instead, a passage 112 is provided between the inlet 17 and the space between the membrane holder 27 and a lid 128, said passage 112 constituting the reference point A in the differential pressure valve 111.

The reference point B is located in the area between the perforations 35 and the slits 25 as is the case in the differential pressure valve 11.

It will be understood that although the differential pressure valves 11 and 111 differ slightly from each other and that it is a question of two different embodiments of central or district heating plants, the differential pressure valves 111 will produce the same effect as the differential pressure valve 11 in the double pipe plant, and it

is therefore regarded as unnecessary to explain the function of the single pipe plant.

Figs. 7 and 8 show preferred embodiments of differential pressure valves 11 and 111 according to the invention for use in double pipe respectively single pipe central or district heating plants.

Figs. 7 and 8 show the numerous components which form parts of the differential pressure valves according to the invention, said components comprising nuts, seals, screws and a planet gear in the hand grip 32 which constitutes a gear for the turning of the spindle in such a way that the displacement of the first bushing 34 can take place with the accuracy necessary.

C L A I M S

1. Method for regulating a central or district heating plant provided with a differential pressure valve (11, 111) for circulating a heat carrying fluid, such as water, through a building with several rooms, each of which has at least one radiator (5) provided with a thermostat valve (16), said differential pressure valve (11, 111) being placed after the radiators (5) in the direction of flow and having a closing device (24, 25) controlled by a membrane (23) for regulating the flow of the heat carrying fluid through a passage (19) between an inlet (17) and an outlet (18), c h a r a c t e r i s e d in that the differential pressure valve (11, 111) is provided with an adjustable throttle (15) between the inlet (17) and the closing device (24, 25), and that the throttle (15) is adjusted to allow a maximum amount of fluid to pass, regardless of the state of distribution of pressure in the plant.

2. Method according to claim 1, c h a r a c t e r i s e d in that the pressure difference between on one side the pressure on a first surface (29) of the membrane (23) on the side turned away from the passage (19), and on the other side the pressure between the throttle (15) and the closing device (24, 25) is used for the differential pressure.

3. Method according to claims 1 and 2, in which the plant is a double pipe plant, c h a r a c t e r i s e d in that the pressure, which exists ahead of the radiators (5) in the direction of flow, is conducted to the first surface (29) of the membrane (23).

4. Method according to claims 1 and 2 in which the plant is a single pipe plant, c h a r a c t e r i s e d in that the pressure, which prevails between the radiators (5) and the differential pressure valve (111) in the direction of flow, is conducted to the first surface (29) of the membrane (23).

5. Central or district heating plant for use in the implementation of the method according to claim 1, said plant being designed to conduct a heat carrying liquid, such as water, and said plant comprising several radiators (5) each provided with a thermostat valve (6), said radiators being designed to be placed in a number of at least one in each room in a building, and with a differential pressure valve (11, 111) being placed after the radiators (5) in the direction of flow, said valve having a closing device (24, 25) controlled by a membrane (23) for regulating the flow of heat carrying liquid in a passage between an inlet (17) and an outlet (18), c h a r a c t e r i s e d in that the differential pressure valve (11, 111) has an adjustable throttle (15) between the inlet (17) and the closing device (24, 25).

6. Plant according to claim 5, c h a r a c t e r i s e d in that the throttle (15) is a first bushing (34) which by means of a threaded spindle (31) is axially displaceable in a second bushing (26) between a first position, in which the end part of the first bushing (34) closes lengthwise perforations (35) in the wall of the second bushing (26), and second position in which the said perforations (35) are free and able to permit unimpeded passage of the heat carrying fluid between the inlet (17) and the outlet (18).

7. Plant according to claims 5 and 6, said which plant being of the double pipe type, c h a r a c t e r i s e d in that the plant comprises a capillary tube (12) extending from a first point (13), which in the direction of flow is positioned ahead of the radiators (5), to a connection (14) provided on a first surface (29) of the memebrane (23) of the differential pressure valve (11), said surface being turned away from the closing device (24, 25).

8. Plant according to claims 5 and 6, said plant being of the single pipe type, c h a r a c t e r i s e d in the the differential pressure valve (111) comprises a passage (112) extending from the inlet (17) to a space, the wall of which consists of the first surface (29) of the membrane (23).

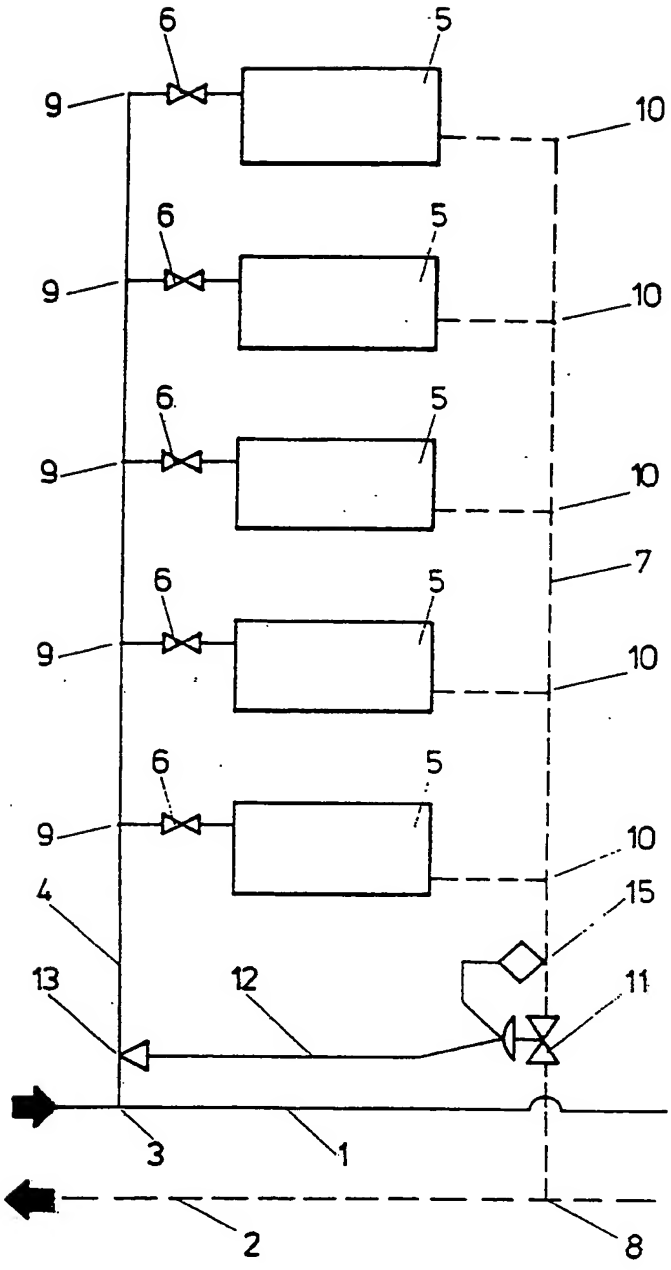


Fig.1

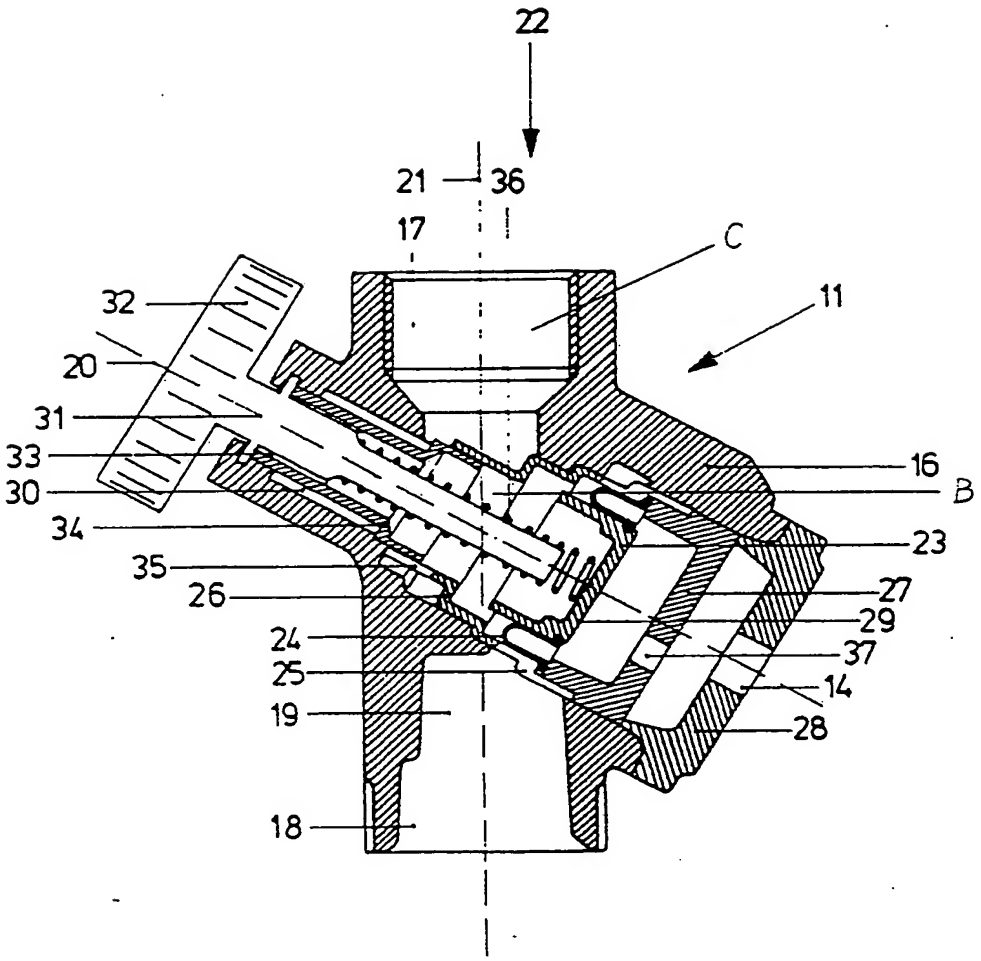

22
21
36
17
C
11
32
20
31
33
30
34
35
26
24
25
19
18
16
B
23
27
29
37
14
28

Fig. 2

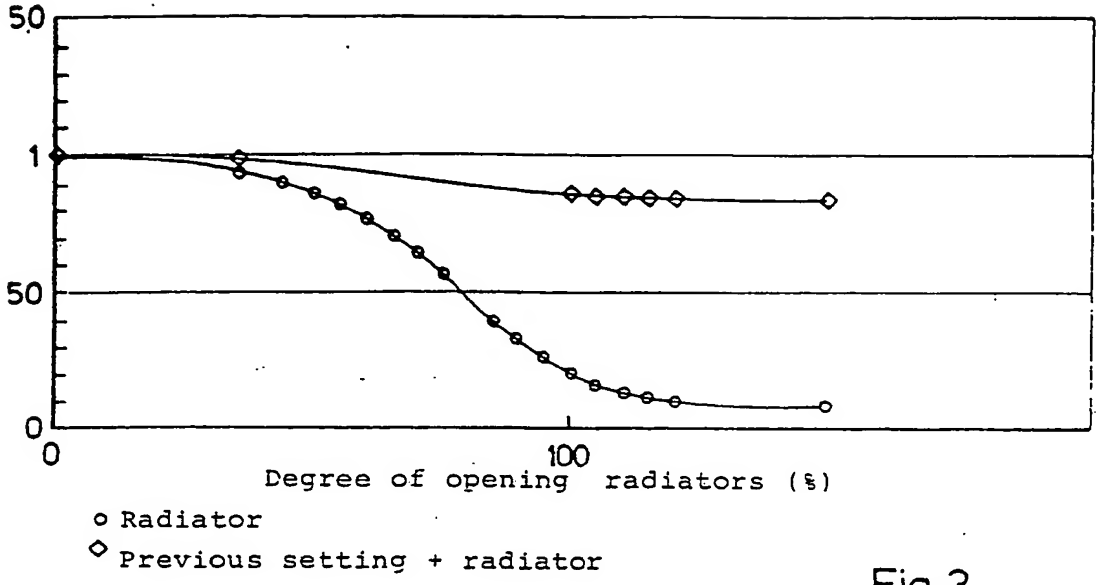

50
1
50
0
0
100
Degree of opening radiators (%)
o Radiator
◇ Previous setting + radiator

Fig.3

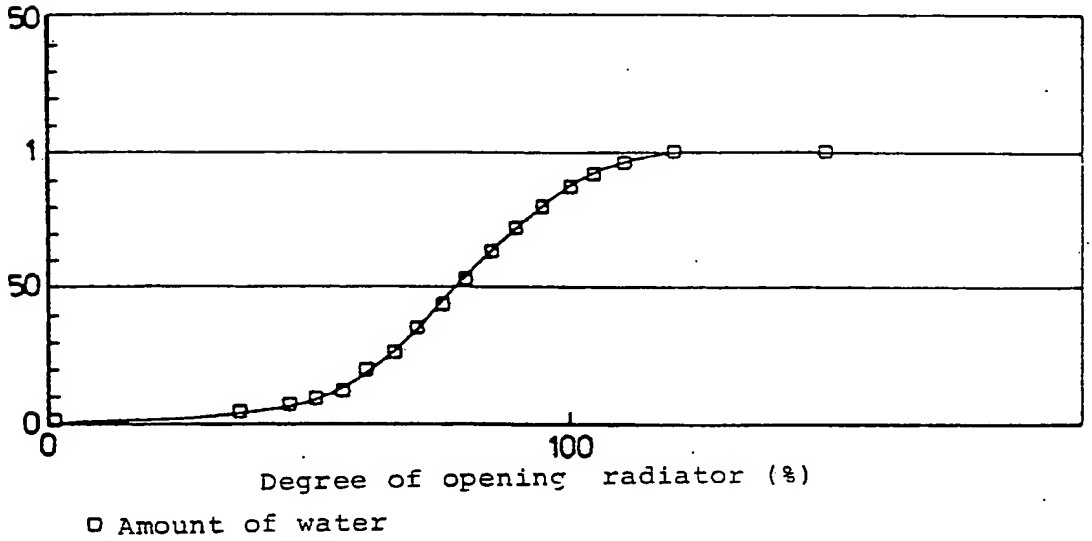

50
1
50
0
0
100
Degree of opening radiator (%)
□ Amount of water

Fig.4

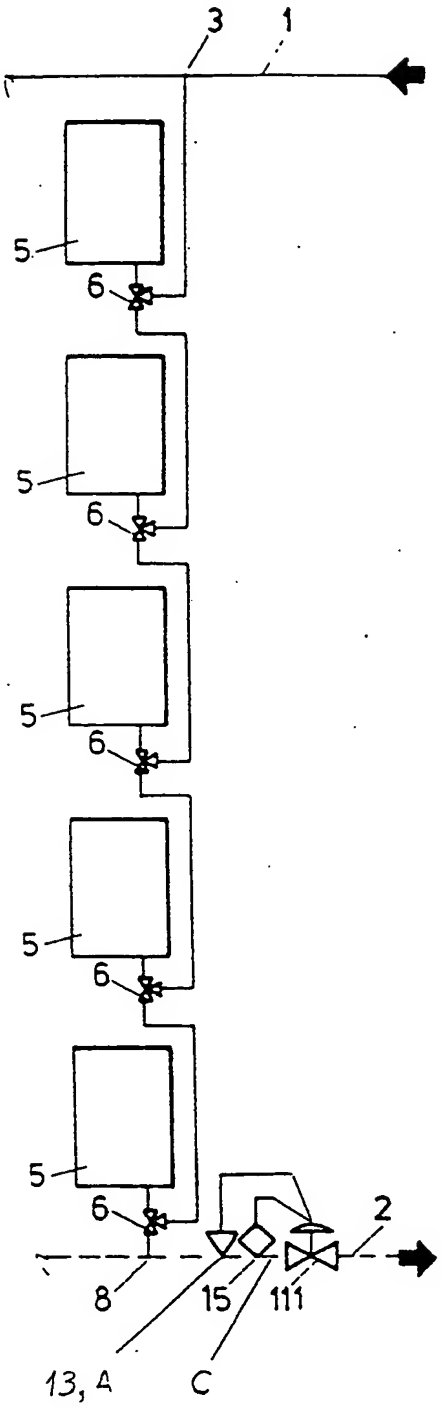


Fig. 5

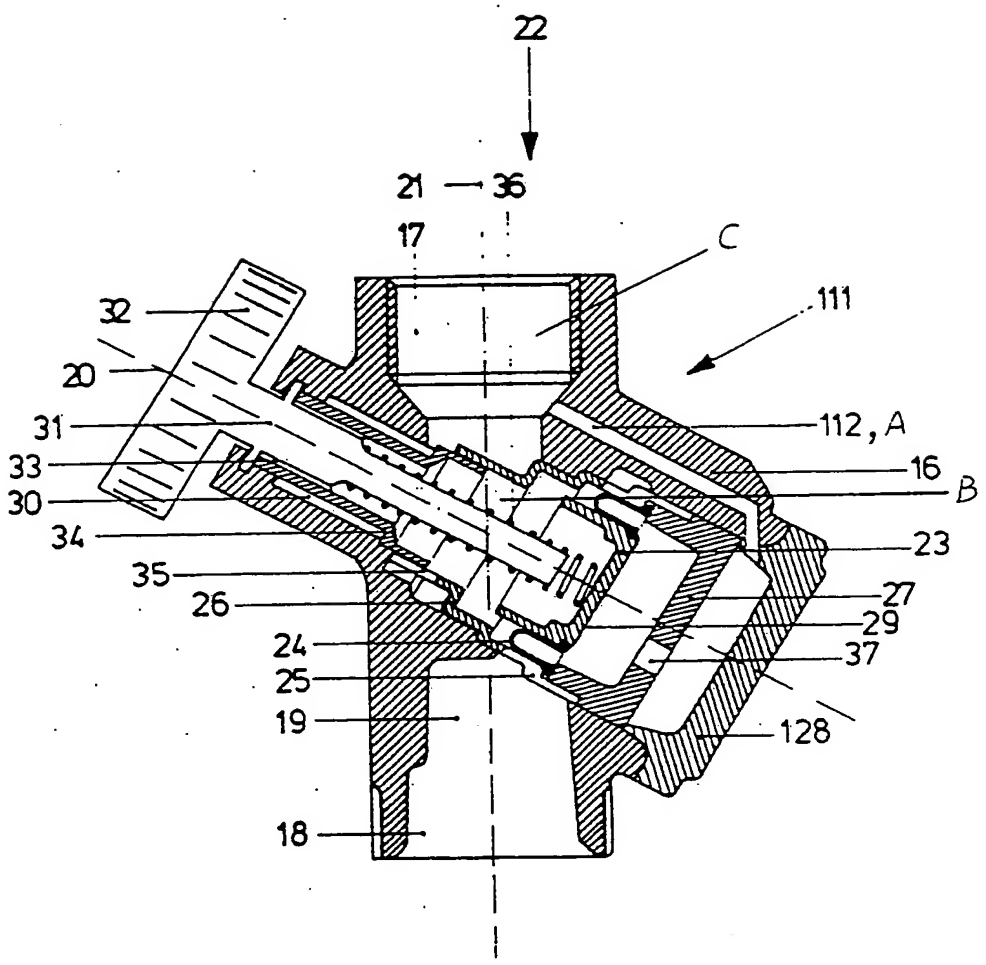

22
21
36
17
C
111
32
20
31
33
30
34
35
26
24
25
19
18
112, A
16
B
23
27
29
37
128

Fig.6

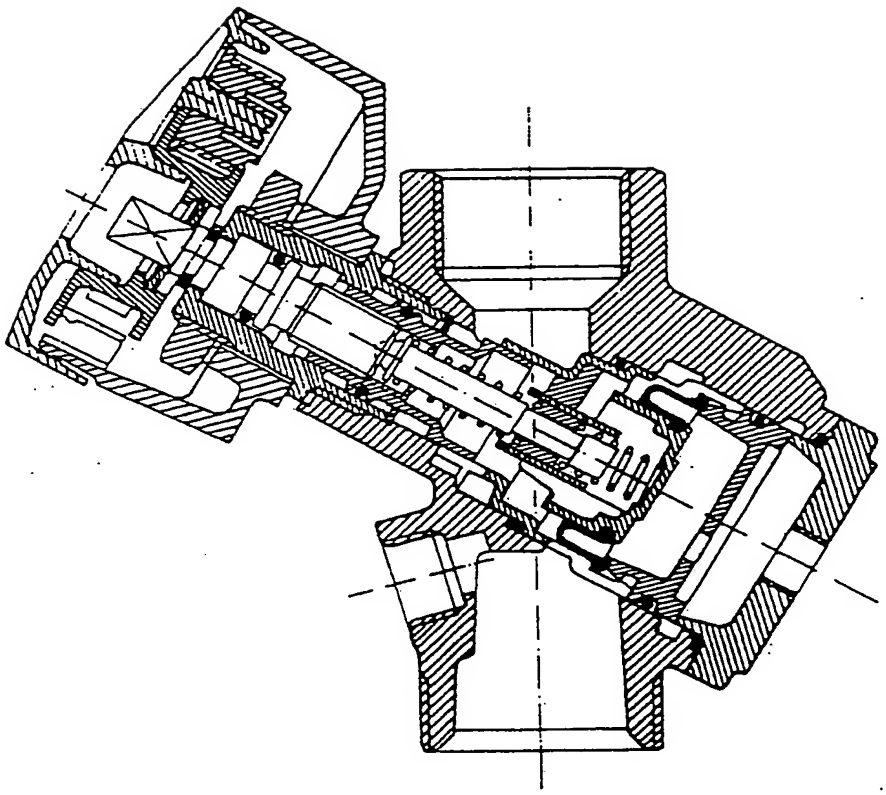


Fig.7

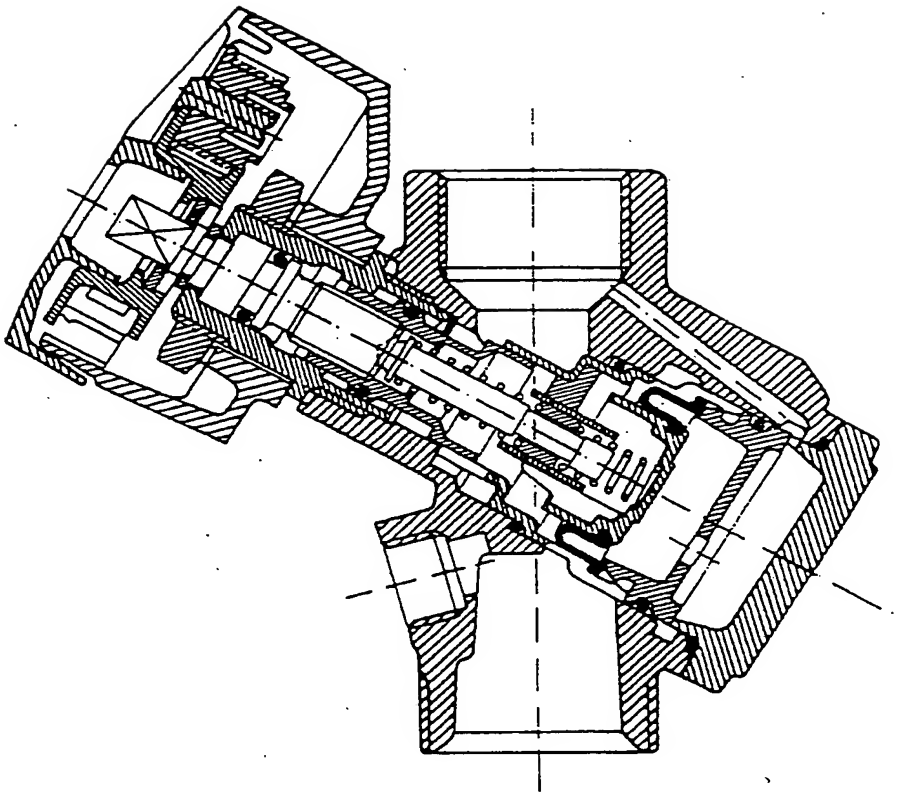


Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK89/00185

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 24 D 19/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	F 24 D 3/00, /02, 19/00, /10; F 24 H 9/20 F 16 K 17/06, /08, /22, /26, /36; G 05 D 27/00 G 05 G 15/08

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	NO, A, 98 383 (MARTIN CHRISTIANSEN) 31 July 1961 See spec. fig. 3 and belonging text	1-8
A	SE, A, 345 002 (E W NILSSON) 8 May 1972 See the whole document	1-8
A	DE, A, 1 253 429 (SAMSON APPARATEBAU A.G.) 2 November 1967 See the whole document	1-8
A	DE, A, 1 197 208 (KARL BORMANN) 22 July 1965 See the whole document	1-8

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1989-11-06	1989 -11- 09
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Inger Löfving

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II. FIELDS SEARCHED (CONT.)

US Cl 73:861.42; 137:455, 458-463, 486
487, 493, 505, 508-510, 514-514.5
852, 859
236:92R, 101R, 102; 237:13

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ..... because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ..... , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ..... because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.